İnönü Üniversitesi Sağlık Hizmetleri Meslek Yüksekokulu Dergisi
ISSN: 2147-7892, Cilt 10, Sayı 2 (2022) 450-461
doi: 10.33715/inonusaglik.1049837

Journal of Inonu University Health Services Vocational School
ISSN: 2147-7892, Volume 10, Issue 2 (2022) 450-461
doi: 10.33715/inonusaglik.1049837

Original Article / Araştırma Makalesi

OBSTRUCTIVE SLEEP APNEA AND CARDIOVASCULAR RISK FACTORS IN THE PATIENTS WITH TYPE 2 DIABETES MELLITUS

Tip 2 Diyabet Mellituslu Hastalarda Obstrüktif Uyku Apnesi ve Kardiyovasküler Risk Faktörleri

Serap GÖKÇE ESKİN[1] *Dide KILIÇALP KILINÇ*[2] *Oğuzhan OĞUZ*[3]
[1,2]*Adnan Menderes University, Faculty of Health Science, Aydın*
[3]*Aydın Public Hospital, Aydın*

Geliş Tarihi / Received: *28.12.2021* ***Kabul Tarihi / Accepted:*** *18.04.2022*

ABSTRACT

The aim of this study is to determine the risk factors of obstructive sleep apnea (OSA) and cardiovascular diseases (CVD) in adult patients with Type 2 diabetes. In this cross-sectional study, the data have been collected from 228 type 2 diabetes patients by using the "Patient Information Form," "Berlin Survey," and "Framingham Risk Score" between March 3 and July 15, 2016. The OSA risk level and factors affecting patients were assessed in this study. Gender, Framingham risk score, BMI, waist/hip ratio, and waist circumference were found to statistically significantly increase the risk of OSA in patients with diabetes. Our data suggest that sleep disturbance is common in patients with Type 2 diabetes, and individuals at high risk for OSA are also at higher risk for CVD. OSA appears to increase the risk of CVD in patients with Type 2 diabetes. When healthcare professionals care for diabetic patients, symptoms of sleep disorders should be evaluated. Sleep disorder symptoms and management should be included in the education programs of diabetic patients.

Keywords: Diabetes Mellitus, Heart diseases, Sleep apnea.

ÖZ

Bu çalışmanın amacı, Tip 2 diyabetli erişkin hastalarda obstrüktif uyku apnesi (OSA) ve kardiyovasküler hastalık (KVH) risk faktörlerini belirlemektir. Kesitsel tipte olan bu çalışmada veriler 3 Mart - 15 Temmuz 2016 tarihleri arasında 228 tip 2 diyabet hastasından "Hasta Bilgi Formu", "Berlin Anketi" ve "Framingham Risk Skoru" kullanılarak toplanmıştır. Bu çalışmada OSA risk düzeyi ve hastaları etkileyen faktörler değerlendirildi. Diyabetik hastalarda; cinsiyet, Framingham risk skoru, VKİ, bel/kalça oranı ve bel çevresinin OSA riskini istatistiksel olarak anlamlı derecede artırdığı bulundu. Verilerimiz Tip 2 diyabetli hastalarda uyku bozukluğunun yaygın olduğunu ve OSA için yüksek risk altındaki bireylerin de KVH için daha yüksek risk altında olduğunu göstermektedir. OSA, Tip 2 diyabetli hastalarda KVH riskini artırıyor gibi görünmektedir. Sağlık çalışanları diyabetik hastalara bakım verirken uyku bozukluğu belirtileri değerlendirilmelidir. Diyabetik hastaların eğitim programlarında uyku bozukluğu semptomları ve yönetimi dahil edilmelidir.

Anahtar kelimeler: Diyabetes Mellitus, Kalp hastalıkları, Uyku apnesi.

Serap GÖKÇE ESKİN✉, serap.gokce@adu.edu.tr
Adnan Menderes University, Faculty of Health Science, Aydın

Bu makaleye atıf yapmak için(How to cite this article): Gökçe Eskin, S., Kılınç Kılıçalp, D. & Oğuz, O. (2022). Obstructive sleep apnea and cardiovascular risk factors in the patients with type 2 diabetes mellitus. İnönü Üniversitesi Sağlık Hizmetleri Meslek Yüksekokulu Dergisi, 10(2), 450-461. doi: 10.33715/inonusaglik.1049837

INTRODUCTION

The most common sleep disorder is Obstructive sleep apnea (OSA) (Ralls & Cutchen, 2019). Worldwide, 425 million people aged between 30-69 have moderate to severe OSA, and 936 million people have mild to severe OSA (Benjafield et al., 2019; Ralls & Cutchen, 2019). OSA is a sleep disorder in which there are episodes of partial or complete upper airway collapse during sleep (Drager et al., 2019). Independent of obesity, OSA can lead to cardiovascular diseases (CVDs) (Alonderis, Varoneckas, Raskauskines, Brozaitiene, 2017; Dursunoglu & Dursunoglu, 2018; Mehra, 2019; Oktay Arslan & Ardıç, 2018). The prevalence of OSA syndrome is high in patients with type 2 DM (Archontogeorgis et al., 2018; Obaseki et al., 2014; Oktay-Arslan &Ardıc, 2018; Umoh, Akpan, Ekrikpo, Idung & Ekp, 2020). The presence of OSA is related to the increased risk of DM (Viswanathan, Ramalingam & Ramakrishnan, 2017; Zhu et al., 2017).

Several mechanisms have been proposed to explain this very high cardiovascular and type 2 diabetes risk in people with OSA, including; activation of the sympathetic nervous system, increased levels of endothelin, oxidative stress, changes in adipokine profiles, and inflammatory activation. OSA has negative synergistic effects on the cardiovascular and endocrine system through multiple mechanisms (Briançon-Marjollet et al., 2015; Meszaros et al., 2020; Shah et al., 2015). Also, type 2 diabetes contributes to the risk of developing CVD. Shah et al. reported in their study that type 2 diabetes was positively associated with cardiovascular diseases (Shah et al., 2015). According to the World Health Organisation, the prevalence of CVD and type 2 diabetes is increasing rapidly—17.5 million deaths (31% of all deaths worldwide) that occurred in the world in 2012 were due to CVD, while diabetes caused 1.5 million (2.7%) deaths in the same year (World Health Organisation [WHO], 2021). Constanzo et al. (2015) reported that 30-50% of patients with heart failure may have OSA.

OSA is a treatable condition; patients with CVD should be proactively screened for OSA to decrease both endocrine and cardiovascular outcomes of OSA (Mehra, 2019). Diabetes management consists of drug therapy, medical nutrition therapy, exercise, self-management and education parameters. Sleep disturbances are ignored in diabetes management.

The aim of this study is to determine the OSA and CVD risks of diabetic patients and the factors affecting these risks, also it is aimed to increase OSA awareness of professionals who care for diabetic patients.

MATERIAL AND METHOD

This study was planned as a descriptive cross-sectional design. The sample of the study consisted of 228 patients who accepted to participate in the study. The participants; were 18 years and older, were cognitively competent, were literate, had standing height and weight measurements and were being monitored for type 2 diabetes in the outpatient clinic of a public hospital between March 3, 2016 and July 15, 2016. The study was conducted with all patients who met the required criteria and volunteered to participate in this study.

Routine tests were performed in the hospital. Patients, who; were using drugs that affect sleep, were taking insulin therapy, had severe painful neuropathy and alcohol dependence were excluded from the study. The degree of obesity was classified based on the results of the 2015 Turkish Nutrition Guide: patients with < 25 kg/m2 body mass index (BMI) were classified as nonobese and ≥ 25 kg/m2 as obese (TUBER, 2015). None of the patients had low weight.

Data collection was done through face-to-face interviews with patients diagnosed with type 2 diabetes in the diabetes polyclinic of the public hospital, which is located in the west region of Turkey. The data collection was done between March 01, 2016 and July 15, 2016. While dependent variable is Berlin score in this study, independent variables are; sociodemographic characteristics, anthropometric measurements, Framingham risk score.

Measurement Tools

In this study, the data were collected by using the “Patient Information Form,” “Berlin Questionnaire (BQ),” and “Framingham Risk Score (FRS).” The FRS was used to evaluate the risk for CVD in the patients, while the BQ was used to evaluate the risk for OSA.

Patient Information Form

This form is comprised of two parts. In the first part, information about DM and sociodemographic characteristics of the patients were collected. In the second part, questions about the BMI of the patients, other diseases that the patients may have, smoking/alcohol consumption status were included among the risk factors for OSA.

Berlin Questionnaire

Through a consensus gathered in the “First Stage Sleep Conference” held in 1996 in Berlin-Germany, this questionnaire is used to obtain the risk of OSA at the community level. The validity and reliability of the scale in the Turkish population were carried out by Acar et al. and the sensitivity of BQ was found to be 87.9% in the study (Acar et al., 2013). The

questionnaire contains 10 items in three categories. If the answer given to at least two items in the first two categories is 1, that category is considered positive (+). The third category is considered positive if the patient has hypertension or the BMI is ≥ 30. If two or three categories are positive, the patient is considered to be at high risk for OSA, and if only one category is positive, the patient is considered to be at low risk for OSA (Acar et al., 2013; Wilson et al., 1998).

Framingham Risk Scoring

Ten-year coronary disease risk is estimated separately for both gender. The calculation includes six risk factors: gender, age, total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), systolic blood pressure (SBP) or diastolic blood pressure (DBP), and smoking. Scores obtained according to values and categories are summed up, and the 10-year probability corresponding to an individual's risk is determined. With this score, only the coronary event risk (fatal and nonfatal sum) is calculated. In this case, < 10% indicates low risk, 10%–20% indicates moderate risk, and > 20% indicates high risk (Kannel, McGee & Gordon, 1976; Wilson et al., 1998).

Bodyweight Measurement/Height Measurement and Body Mass Index

The patients' body weights were measured with a calibrated and ± 0.5 kg precision weighing instrument, in the morning while the patients were standing upright. The measurements were carried out before the participants ate anything. The participants were asked to wear thin clothes and no shoes. The weight and height measurements of the patients were made by the researcher. The BMI was calculated as body weight in kilograms divided by the square of height in meters (kg/m m2). BMI values of less or greater than the normal values (18.50–24.99 kg/m m2) were considered an indicator of increased health risk (TUBER, 2015).

Waist Circumference Measurement

The waist circumference value gives an idea of the abdominal adipose tissue (i.e., organ fat). While the person to be measured was standing, the lowest rib on the right side was located and marked. On the hip, the hip bone protrusion (iliac)

was located and marked. The midpoint between the two marks was located, and the waist circumference passing through this point was measured. A waist circumference of greater than 94–102 cm in males and 80–88 cm in females is considered to be a risk factor for many diseases (TUBER, 2015).

Hip Circumference Measurement

The researcher stood by the side of the patient and measured the circumference at the highest point. After measuring the waist and hip circumference, the waist/hip ratio was determined.

Waist/Hip Circumference Ratio

The waist/hip circumference ratio is calculated as waist measurement divided by hip measurement. Hip circumference was measured from the widest circumference of the hip while the patient was standing. According to the World Health Organization (WHO), waist/hip ratio should be < 0.90 in males and < 0.85 in females. Waist/hip ratio > 0.90 in males and > 0.85 in females is indicated as increased health risk (TUBER, 2015).

Other Measurements

Blood pressure was measured with a mercury sphygmomanometer. TC, HDL-C levels were measured from venous blood by enzymatic methods using a Hitachi 7150 autoanalyzer (Hitachi, Tokyo, Japan).

Statistical Analysis

In this descriptive study, the demographic characteristics of the participants and their responses to the scaled questionnaire were analyzed objectively. IBM SPSS 22.0 software package was used for the statistical analysis of the data. The demographic characteristics of those who volunteered to participate in the survey were analyzed, and the frequency distributions of the data were presented. The scale data were analyzed using the chi-square test in paired groups and the Mann- Whitney U (MWU) test in groups of three or more. Results were evaluated at a 95% confidence interval and a significance level < 0.05. Pearson correlation analysis was performed to reveal the differences in terms of age, BMI, waist circumference, waist/hip ratio, SBP, DBP, TC, HDL, and FRS. The significance levels of correlations were accepted as 0.05.

Ethics Approval

Ethics committee approval was obtained from the Adnan Menderes University Faculty of Medicine Non-Interventional Clinical Research ethics committee with 14.04.2016 date and 53043469/050.04-108 number. This research was conducted in accordance with accepted national and international (Helsinki Declaration) standards. Written informed consent was

obtained from all the participants. The privacy of study subjects was maintained. There is no conflicts of interest.

RESULTS

According to our study, mean of age was 54.46±11.46, of the type 2 diabetes patients 144 (63.1%) were females and 84 (36.85%) were males (Tables 1 and 2). Also, 65.9% of the participants with a BMI value of greater than 30 kg/m2 and 64.9% of those who were receiving hypertension treatment were females. Of the males participating in the study, 80.9% had a high FRS and 50.7% had a high risk of OSA. On the other hand, 19.1% of females had high FRS and 49.3% had high risk of OSA (Table 1).

Table 1. Descriptive Findings by Gender

		Male (n=84)		**Female (144)**	
		N	%	N	%
Alcohol consumption	Yes	20	90.9*	2	9.1*
	No	64	31.1*	142	68.9*
Smoking status	Yes, more than 10 a day	19	65.5*	10	34.5*
	No	65	32.7*	134	67.3*
BMI	<30 kg/cm^2	13	65.0*	7	35*
	>30 kg/cm^2	71	34.1*	137	65.9*
Receiving treatment for hypertension	Yes	34	35.1*	63	64.9*
	No	50	38.2*	81	61.8*
Systolic blood pressure	<130	25	30.5*	57	69.5*
	>130	59	40.7*	86	59.3*
Diastolic blood pressure	<85	61	35.9*	109	64.1*
	>85	23	40.4*	34	59.6*
Framingham risk score	Equal to or less than 10	39	24.2*	122	75.8*
	10-20	38	80.9*	9	19.1*
Waist / hip ratio risk assessment	Non-risk	21	33.9*	41	66.1*
	Risky	61	37.7*	101	62.3*
Berlin	Non-risk	16	17*	78	83*
	Risky	68	50.7*	66	49.3*

*Line percentage was taken.

The mean total cholesterol was 54.46 ± 11.46 mg/dl, the mean systolic blood pressure was 78.80 ± 10.10 mm/Hg, the waist/hip ratio was 0.91 ± 0.087 and waist circumference was 108.74 (Table 2).

Table 2. Descriptive Findings for Parametric Variables

	Female		**Male**		**Total**	
	Min.-Max.	Mean±std dev.	Min.-Max.	Mean±std dev.	Min.-Max.	Mean±std dev.
Age	26-78	54.36±11.12	18- 80	54.62±12.09	18-80	54.46 ±11.46
Total cholesterol	82-404	193.41±53.90	87-302	166.48±55.64	82-404	183.29±55.98
HDL	12-97	55.49±14.87	25-88	56.98±14.63	12-97	56.06 ±14.77
Systolic blood pressure	100-200	131.51±18.47	90-180	136.05±18.46	90-200	133.20±18.56
Diastolic blood pressure	50-114	78.39±10.26	60-104	79.48±9.86	50-114	78.80 ±10.10
Waist / hip	0.61-1.1	0.89±0.07	0.681.25	0.95±0.09	0.61-1.25	0.91 ±0.087
Waist circumference	67-140	108.49±12.53	65-149	109.15±15.14	65-149	108.74±13.51

Of the participants who consume alcohol, 90.9% were males, while 9.1% were females. Smoking status was 65.5% in males and 34.5% in females. The effect of alcohol consumption (p=0.180) and smoking (p=0.691) on OSA syndrome was found to be insignificant (Table 3).

Table 3. OSA Risk Level in Patients and Factors Affecting It

		Non-risk	**Risk**	**P value**
		n (%)	n (%)	
Gender	Male	16 (19)	68 (81.0)	P=0.000*
	Female	78 (54.2)	66 (45.8)	
Alcohol	Yes	6 (27.3)	16 (72.7)	P=0.180*
	No	88 (42.7)	118 (57.3)	
Smoking	Yes	13 (44.5)	16 (55.2)	P=0.691*
	No	81 (40.7)	118 (59.3)	
BMI	<30kg/m^2	10 (50)	10 (50)	P=0.478*
	>30kg/m^2	84 (40.4)	124 (59.6)	
Receiving treatment for hypertension	Yes	41 (42.3)	56 (57.7)	P=0.630*
	No	53 (40.5)	78 (59.5)	
Systolic blood pressure	<130	35 (42.7)	47 (57.3)	P=0.779*
	>130	58 (40)	87 (60)	
Diastolic blood pressure	<85	66 (38.8)	104 (61.2)	P=0.787*
	>85	27 (47.4)	30 (52.6)	
Framingham risk score	Equal to or less than 10	70 (43.5)	91 (56.5)	P=0.028*
	10-20	12 (25.5)	35 (75.5)	

According to the results of the research, 54.2% of the women and 19% of the men among the participants were not at risk for OSA (Berlin Questionnaire). Gender, waist/hip ratio, FRS, waist circumference, BMI were found to have a statistically significant effect on the risk of OSA (p<0.05) (Table 3, Table 4).

Table 4. Mean of Variables Affecting OSA Risk

Parameters	Mean	P
Age	54.45±11.4	P= 0.330
Waist /Hip Ratio	0.91±0.087	P=0.022
BMI	32.4±6.08	P=0.000
Waist circumference	108.74±13,51	P=0.000
TC	183.28±55.9	P=0.330
HDL	56±14.7	P=0.514

In the multiple regression analysis performed to evaluate the effect of four independent variables which have effect on OSA risk, it was seen that the variables explained the change in OSA risk of the participants at the rate of 22% (Table 5). The variables, that were found to be significantly effective according to the t-test results regarding the significance of the regression coefficients, were determined as gender and BMI according to the standardized regression coefficient. The increase in the value/score in the gender represents the status of being female and it was seen that the OSA risk decreased in the direction of decreasing the total scores (negative relationship), while the increase in the BMI value increased the OSA risk (positive relationship) (Table 5).

Table 5. Effect of Independent Variables on OSA Risk: Multiple Regression Analysis Results

Dependent	Independent	B	Std. Err	β	t	p
Berlin Questionnaire (OSA risk)	BMI ($kg/m^{2)}$	.052	.010	.382	5.044	.000
	Waist(cm)	-.002	.004	.038	.514	.607
	Hip/Waist	.008	.107	.040	.701	.944
	Gender	-.701	.107	-.403	6.521	.000

Adjust R^2: .220 F: 16.881 p:.000 Durbin Watson:1.697

A low level of positive correlation was found according to the correlation analysis made between FRS and OSA risk score (R: .153; p:.021).

DISCUSSION

This study aimed to investigate the relationship between OSA risk level and CVD risk level in patients with type 2 diabetes within the framework of FRS and Berlin form criteria. In this study, gender, BMI, waist circumference, waist-hip ratio, FRS had a statistically significant effect on OSA risk. According to multiple regression analysis, gender and BMI increase affect the risk of OSA by 22%. OSA syndrome is characterized by recurrent obstructions of the upper airway during sleep. Male gender, genetic characteristics, obesity, hypertension, dyslipidemia smoking, alcohol have been reported to be the main predisposing factors (male, age, high BMI, smoking) that increase the tendency to develop OSA

(Bouloukaki et al., 2019; Drager et al., 2019). These factors are also CVD risk factors. However, hypertension, DM and ischemic heart disease may accompany OSA (Atılgan, Demirdas & Cicekcioglu, 2018; Mehra, 2019; Zhu et al., 2017). The effect of other factors was not determined in our study.

In this study, we found that the risk of OSA was high in the majority of the males. The risk of OSA in male diabetic patients is higher. Similar to our study, Huang et al. reported that males had a higher risk for OSA than females (Huang et al., 2018). In one study, men were more likely than women to complain of OSA symptoms (Bouloukaki et al., 2019). In another study, the prevalence of OSA was higher in men than in women (Wali et al., 2017). According to the literature; some factors associated with OSA (male gender, age, BMI, waist-to-hip ratio, snoring, alcohol consumption and cardiovascular diseases) were determined (Alendoris et al., 2017; Bouloukaki et al., 2019; Drager et al., 2019; Fietze et al., 2019; Huang et al., 2018; Wali, Abalkhail & Krayem, 2017). In a study women exhibited stronger associations than men (Fietze et al., 2019). Androgenic fat that often occurs in males causes central obesity and the abdominal fat that emerges in central obesity negatively affects the upper respiratory tract patency and breathing pattern. In addition, it is known that the risk of OSA is high in men due to differences in brain activity, upper respiratory tract anatomy and hormonal differences, which supports our findings. (Benjafield et al., 2019; Fietze et al., 2019; Muñoz -Torres, Jiménez-Correa, Montes-Rodríguez, 2020).

The BMI effect on the OSA risk level was found to be significant ($p = 0.009$). The increase in the BMI index increases the risk of OSA in diabetic patients. In relation to this, the mean waist/hip ratio of the majority of individuals at high risk in terms of waist/hip ratio risk assessment was 0.97. The effect of the waist/hip ratio on OSA was found to be significant ($p = 0.000$). Obesity has been reported as an important risk factor for OSA (Alonderis et al., 2017; Drager et al., 2019; Mokhlesi et al., 2019; Wali et al., 2017). Obaseki et al. (2014) documented a high risk for OSA in patients with diabetes who had a BMI value of greater than 30 kg/m2. Waist circumference and waist-hip ratio increase in obesity. In a study conducted on patients with diabetes, the waist circumference of individuals with high OSA risk was significantly higher than those with low waist circumference (Mokhlesi et al., 2019). Another study reported that individuals with a high waist-hip ratio had a high risk for OSA (Umoh et al., 2020). Fat accumulation due to obesity, especially in the waist region, can increase the pressure on the diaphragm and cause difficulty breathing, and increased weight increases the respiratory load. Accordingly, it is thought that the risk of OSA increases in patients with obesity and individuals with a high waist and waist/hip. In the Berlin form

evaluation, 58.8% of the participants were found to have a high risk for OSA. In a cross-sectional study, approximately half of the patients with diabetes (49.5%) were found to be in the high-risk group (Umoh et al., 2020). OSA was a risk factor for the diabetes (Viswanathan et al., 2017; Zhu et al., 2017). Hypoxia significantly increases sympathetic nervous system activity. Intermittent hypoxia affects insulin-target organs such as adipose tissue, liver, and skeletal muscle, as well as pancreatic insulin production and secretion.

Hyperglycemia resulting from this leads to an increase in hepatic gluconeogenesis and a decrease in glucose reuptake in skeletal muscles. It also seriously stimulates insulin resistance (Briançon-Marjollet et al., 2015). Accordingly, the risk of OSA is high in people with diabetes. This is consistent with our findings.

The majority of patients with diabetes participating in the present study appeared to have a low FRS. However, there is a weak positive correlation between FRS and OSA risk score. Patients with an increased risk of heart disease also have an increased risk of OSA. Archontogeorgis et al. (2018) reported that high FRS was associated with poor sleep efficiency. The hypoxia that occurs in OSA causes a change in cholesterol metabolism as well as an increase in epinephrine secretion and cardiovascular risk. Therefore, patients with high OSA risk included in our study may have had higher FRS. However, FRS reveals a 10-year cardiovascular risk. The fact of the diabetic participants to have low FRS may be related to the diabetes development year. In our study, the diabetes diagnosis year was not determined among the participants. The risk of CVD due to diabetes will increase as the year increases. The obtained results seem to be consistent with the literature. In conclusion, according to our data, we can say that sleep disturbance is common in patients with type 2 diabetes. On the other hand, it has been concluded that patients with high OSA risk are also at higher risk of CVD. OSA is thought to also increase the risk of CVD among patients with type 2 diabetes. It is known that CVD and OSA can be both a cause and a result of each other and often accompany each other. Therefore, early detection and treatment of sleep disorders in patients with type 2 diabetes is recommended. This intervention is important for the reduction and prognosis of the CVD risk resulting from sleep disorders. Also health professionals should include symptoms and management of sleep disorders in their diabetes education programs.

Acknowledgements

We appreciate the cooperation of all in the study. We thank all the study participants for their voluntary participation.

REFERENCES

Alonderis, A., Varoneckas, G., Raskauskiene, N. & Brozaitiene, J. (2017). Prevalence and predictors of sleep apnea in patients with stable coronary artery disease: A cross-sectional study. *Therapeutics and Clinical Risk Management*, 13, 1031–1042. https://doi.org/10.2147/TCRM.S136651

Archontogeorgis, K., Voulgaris, A., Nena, E., Strempela, M., Karailidou, P., Tzouvelekis, A., …Steiropoulos, P. (2018). Cardiovascular risk assessment in a cohort of newly diagnosed patients with obstructive sleep apnea syndrome. *Cardiology Research and Practic*e, 6572785. https://doi.org/10.1155/2018/6572785

Acar, V.H., Kaya, A., Genc, F., Erdem, M., Ceyhan, A., Özgen, F., …Dikmen, B. (2013). Can Berlin questionnaire be used a screening test for obstructive sleep apnea? *Journal of Ansetesia*, 21, 99-105.

Atılgan, K., Demirdas, E. & Cicekcioglu, F. (2018). Effect of obstructive sleep apne syndrome on cardiac and vascular diseases. *Bozok Med. J,* (Special issue), 92-95.

Benjafield, A. V., Ayas, N. T., Eastwood, P. R., Heinzer, R., Ip, M., Morrell, M. J., …Malhotra, A. (2019). Estimation of the global prevalence and burden of obstructive sleep apnoea: a literature-based analysis. The Lancet. *Respiratory Medicin*e, 7(8), 687–698. https://doi.org/10.1016/S2213-2600(19)30198-5

Briançon-Marjollet, A., Weiszenstein, M., Henri, M., Thomas, A., Godin-Ribuot, D. & Polak, J. (2015). The impact of sleep disorders on glucose metabolism: endocrine and molecular mechanisms. *Diabetology & Metabolic Syndrome*, 7, 25. https://doi.org/10.1186/s13098-015-0018-3

Bouloukaki, I., Mermigkis, C., Markakis, M., Pataka, A., Alexaki, I., Ermidou, C., …Schiza, S. E. (2019). Cardiovascular effect and symptom profile of obstructive sleep apnea: does sex matter?. *Journal of Clinical Sleep Medicine: JCSM : Official publication of the American Academy of Sleep Medicine*, 15(12), 1737–1745. https://doi.org/10.5664/jcsm.8074

Costanzo, M. R., Khayat, R., Ponikowski, P., Augostini, R., Stellbrink, C., Mianulli, M., …Abraham, W. T. (2015). Mechanisms and clinical consequences of untreated central sleep apnea in heart failure. *Journal of the American College of Cardiology,* 65(1), 72–84. https://doi.org/10.1016/j.jacc.2014.10.025

Drager, L. F., Santos, R. B., Silva, W. A., Parise, B. K., Giatti, S., Aielo, A. N., …Bensenor, I. M. (2019). OSA, short sleep duration, and their ınteractions with sleepiness and cardiometabolic risk factors in adults: The ELSA-Brasil study. *Chest,* 155(6), 1190–1198. https://doi.org/10.1016/j.chest.2018.12.003

Dursunoğlu, D. & Dursunoğlu, N.(2018). Cardiovascular diseases and sleep disordered breathing: what to do and what to watch? *Turkiye Klinikleri J Cardiol-Special Topics*,11,73-76.

Fietze, I., Laharnar, N., Obst, A., Ewert, R., Felix, S. B., Garcia, C., …Penzel, T. (2019). Prevalence and association analysis of obstructive sleep apnea with gender and age differences - Results of SHIP-Trend. *Journal of Sleep Research*, 28(5), e12770. https://doi.org/10.1111/jsr.12770

Huang, T., Lin, B. M., Markt, S. C., Stampfer, M. J., Laden, F., Hu, F. B., …Redline, S. (2018). Sex differences in the associations of obstructive sleep apnoea with epidemiological factors. *The European Respiratory Journal*, 51(3), 1702421. https://doi.org/10.1183/13993003.02421-2017

Kannel, W. B., McGee, D. & Gordon, T. (1976). A general cardiovascular risk profile: the Framingham Study. *The American Journal of Cardiology*, 38(1), 46–51. https://doi.org/10.1016/0002-9149(76)90061-8

Mehra R. (2019). Sleep apnea and the heart. *Clevel and Clinic Journal of Medicine*, 86(9 Suppl 1), 10–18. https://doi.org/10.3949/ccjm.86.s1.03

Meszaros, M., Tarnoki, A. D., Tarnoki, D. L., Kovacs, D. T., Forgo, B., Lee, …Bikov, A. (2020). Obstructive sleep apnea and hypertriglyceridaemia share common genetic background: Results of a twin study. *Journal of Sleep Research*, 29(4), e12979. https://doi.org/10.1111/jsr.12979

Mokhlesi, B., Temple, K. A., Tjaden, A. H., Edelstein, S. L., Nadeau, K. J., Hannon, T. S., …Van Cauter, E. (2019). The association of sleep disturbances with glycemia and obesity in youth at risk for or with

recently diagnosed type 2 diabetes. *Pediatric Diabetes*, 20(8), 1056–1063. https://doi.org/10.1111/pedi.12917

Muñoz-Torres, Z., Jiménez-Correa, U. & Montes-Rodríguez, C. J. (2020). Sex differences in brain oscillatory activity during sleep and wakefulness in obstructive sleep apnea. *Journal of Sleep Research*, 29(4), e12977. https://doi.org/10.1111/jsr.12977

Obaseki, D. O., Kolawole, B. A., Gomerep, S. S., Obaseki, J. E., Abidoye, I. A., Ikem, R. T., …Erhabor, G. E. (2014). Prevalence and predictors of obstructive sleep apnea syndrome in a sample of patients with type 2 Diabetes Mellitus in Nigeria. *Journal of the Nigeria Medical Association*, 55(1), 24–28. https://doi.org/10.4103/0300-1652.128154

Oktay Arslan, B. & Ardıç, S. (2018). Obstructive sleep apnea syndrome and cardiometabolic consequences. *Turkiye Klinikleri J Pulm Med-Special Topics*, 11, 168-173.

Shah, N., Allison, M., Teng, Y., Wassertheil-Smoller, S., Sotres-Alvarez, D., Ramos, A. R., …Kaplan, R. C. (2015). Sleep apnea is independently associated with peripheral arterial disease in the Hispanic community health study/study of latinos. *Arteriosclerosis, Thrombosis, and Vascular Biology*, 35(3), 710–715. https://doi.org/10.1161/ATVBAHA.114.304625

Ralls, F. & Cutchen, L. (2019). A contemporary review of obstructive sleep apnea. *Current Opinion in Pulmonary Medicine*, 25(6), 578–593. https://doi.org/10.1097/MCP.0000000000000623

Turkey Nutrition Guide. (TÜBER 2015). (2016). *Turkish Republic Ministry of Health Publication*. No, 1031, Ankara.

Umoh, V. A., Akpan, E. E., Ekrikpo, U. E., Idung, A. U. & Ekpe, E. E. (2020). The risk of obstructive sleep apnea among patients with type 2 diabetes mellitus. *Journal of the Nigeria Medical Association*, 61(1), 32–36. https://doi.org/10.4103/nmj.NMJ_129_19

Wali, S. O., Abalkhail, B. & Krayem, A. (2017). Prevalence and risk factors of obstructive sleep apnea syndrome in a Saudi Arabian population. *Annals of Thoracic Medicine*, 12(2), 88–94. https://doi.org/10.4103/1817-1737.203746

Wilson, P. W., D'Agostino, R. B., Levy, D., Belanger, A. M., Silbershatz, H. & Kannel, W. B. (1998). Prediction of coronary heart disease using risk factor categories. *Circulation*, 97(18), 1837–1847. https://doi.org/10.1161/01.cir.97.18.1837

World Health Organisation (WHO 2020). In 20 September 2020 retrieved from://www.who.int/news-room/fact-sheets/detail/diabetes.

Viswanathan, V., Ramalingam, I. P. & Ramakrishnan, N. (2017). High prevalence of obstructive sleep apnea among people with type 2 diabetes mellitus in a tertiary care center. *The Journal of the Association of Physicians of India*, 65(11), 38–42.

Zhu, Z., Zhang, F., Liu, Y., Yang, S., Li, C., Niu, Q. & Niu, J. (2017). Relationship of obstructive sleep apnoea with diabetic retinopathy: A meta-analysis. *Biomed Research International*, 4737064. https://doi.org/10.1155/2017/4737064